# JOURNAL

OF

# THE ASIATIC SOCIETY.

*No. 44.—August, 1835.*

## I.—*Geological Sketch of the Neilgherries, (Níl-giri.) By Dr.* P. M. Benza, *Surgeon to the Honorable the Governor of Madras.*

[Read at the Meeting of the 5th instant.]

The group of hills, called the Neilgherries, may be considered as the southern termination of the Western Ghâts, which at this place end in abrupt, lofty, and almost vertical precipices; the extensive valley of Coimbatúr, dividing them from the Pálghât chain, which, in the same direction as the Ghâts, extends down to Cape Comorin.

The Neilgherries form an elevated plateau, projecting in an easterly direction, from the line of the ghâts, in the form of a triangle, the base of which is the continuation of the ghâts themselves,

They rise abruptly from the table-land of Mysore, in stupendous cliffs, with an elevation of many thousand feet. Two rivers encircle them, as it were, running round their base. The Bhowání river, rising in the western side of the Kúndas, and among all the hills of that group, runs in an easterly direction along the foot of the side of the Neilgherries, and, just below the apex of the triangle, is joined by the Moyar, which together with the Paykar, having their origin in the Noddimatty range precisely opposite the sources of the Bhowání, and making a sharp curve after leaving the hills, runs an easterly course, joining the Bhowání at Dánikncottah, and under that name, after running about 30 miles, they discharge their water into the Cavery.

The Neilgherries*, being the highest hills in the whole of the peninsula, south of the Himálaya, possess a greater degree of geological interest than any other group in this extensive region.

* "The Neilgherry Hills are situated between the parallels of 11° 10′ and 11° 32′ N. latitude, and 76° 59′ and 77° 31′ E. longitude from Greenwich; their greatest extent in an oblique direction, from S. W. to N. S. is from 38 to

Their being almost in the middle of a district, in which one of the most interesting rocks in the Indian formations (the laterite) is found developed in all its characteristic features, adds not a little to their importance in a geological point of view. On account of their superior elevation, they ought to be carefully examined by the geologist, before he extends his researches to the other parts of the chain, of which they form the most elevated point.

It was, undoubtedly, after consideration of this kind, that the late Doctor Turnbull Christie, of the Madras Medical Establishment, had begun his geological survey of the peninsula from the Neilgherries, as from a point where the rocks, found at a lower level, are seen in their original state, unmodified, and unaltered by formations and deposits, which events and revolutions, subsequent to the elevation of the whole chain of the western ghâts, must have produced; and had his life been spared, he would, undoubtedly, have given to the public the most accurate and comprehensive account of the geological formations of this interesting part of India, and would have settled many doubtful points in Indian geology, which now keep many of the ablest geologists in a state of uncertainty and suspense.

The few memoirs he published regarding the geology, not only of India, but of those places through which he journeyed, particularly of Sicily, show what was to be expected from a man, who evinced so much information and accuracy of observation on those subjects. Unfortunately for Indian geology, he was cut off at the very beginning of his labours on these very hills, which had in preference attracted his attention and researches.

We are told that the experienced eye of the geologist can easily guess the nature of the rock composing a hill or a system of hills, by the simple inspection of its outlines: thus, spiry peaks show the formation to be primitive; rounded smooth outlines are indicative of calcareous mountains; while the castellated ruin-like appearance of a mountain, is proper to the sandstone formation.

This criterion, however, would lead into error regarding the nature of the rocks forming the Neilgherries. Although their contour is even, smooth, rounded, and, as it were, undulating, the fundamental rocks of which they are composed belong to the primitive class.

Their outline resembles those hills and eminences we meet in districts, resulting from tertiary or alluvial deposits. What the rock

40 miles, and their extreme breadth 15; taking in account the great undulations of the surface, and the breadth above stated being pretty constant throughout, their superficial extent may be fairly estimated at from 6 to 700 square geographical miles.—*Baikie's Observations on the Neilgherries.*

is, which gives those hills the rounded form they exhibit, will be shown hereafter.

With the exception of some vertical cliffs and mural precipices, seen in the boundaries of this elevated plateau, and a few projecting masses of the fundamental rocks on the summits and declivities of these hills, the whole group is uniformly covered by a thick stratum of vegetable earth (No. 1*), which overlying a thicker stratum of red earth, (to be described in the sequel,) supports numerous plants, chiefly grasses, which, growing most luxuriantly in thick contiguous tufts, give the surface a smooth carpet-like appearance. This vegetable earth in general is clayey, and of a grey colour, and very friable. On this soil we occasionally see small rounded pieces of the decomposed subjacent rock, bestrewed particularly on those spots where blocks of the decomposing rock are seen jutting through the soil.

This vegetable soil is replaced in the low valleys and flats at the foot of the hills, by a black soil, such as we frequently see forming the peat-bog in swampy grounds, in which a large quantity of vegetable matter is decomposing (No. 2).

This soil is of a black, or deep brown, colour; of tenacious consistence, when moist; crumbling into powder, and often splitting into prismatic masses, when dry. At first sight, it resembles the black soil of the plains of India. From this last, however, it seems to differ greatly, in containing a large quantity of carbonaceous matter, and much oxide of iron.

To deprive this black soil of the greater portion of its humidity, I exposed it to a heat, sufficient to melt lead, and after having weighed a certain quantity of it, subjected it to an intense heat for an hour; after this, it had lost more than 25 per cent. of the original weight, and had changed into an ochrey red powder (No. 3), without undergoing any vitrification, as is the case with the black soil of the Deccan, (Voysey.) It would therefore appear, that the loss is owing to the oxidification and consequent volatilization of the carbonaceous matter.

This soil, although more frequently found in low situations, is often seen in a thick stratum on the declivities of the hills, such as on the slope of one of the Dodabetta group, facing the cantonment; on that of the Elk Hills, (S.) above South Downs; near the Kaití Pass, and in many other localities, where I have remarked about it, a most luxuriant vegetation of innumerable ferns, of which the roots are seen decaying into a black powder.

In many places below this black soil, and sometimes under the

* The figures refer to specimens deposited in the As. Soc. museum; the letters to the accompanying Map.—Ed.

vegetable earth, we see thick beds of a yellow ochraceous earth abounding with silica (No. 4). Indeed, in some places, as at Kotagherry, it resembles very much the yellow Venetian Tripoli, previous to undergoing preparation for the arts (No. 5). The geological position, however, of the two, differs very much—the Venetian Tripoli, which is brought there from Corfu, and from the neighbouring coasts of Epirus, is found (as I have had opportunities of ascertaining) in the sandstone formation, which alternates with the magnesian limestone*. The kind of Tripoli I met with on the Neilgherries, seems to be the result of the disintegration of a species of iron flint found in primitive formations; some of the specimens I collected, have a great resemblance to the Eisnkeissel of Werner (No. $5\frac{1}{2}$). Some varieties of the finest white Tripoli arise from the decomposition of silicious rocks, such as calcedony, in Corfu and in upper Italy; but in general, the Neilgherry specimen is not so silicious, and seems to contain a good deal of alumina and iron. It is in this yellow clay that we occasionally see some tubular bodies, formed by concentric layers of the same clay, round the numerous roots of plants that grow on the soil above (No. 6). But what attracted my attention most was, to see (at Kotagherry) those tubular bodies traversing the thick stratum of black earth, which overlies the yellow clay, without having a particle of it in their composition. As if the roots, by a kind of capillary attraction, sucked up through the black soil, without mixing with it, the particles of the yellow clay which, undisturbed by the vicinity of the black soil, arranged themselves concentrically to the root; and the latter decaying has left the cavity of the tube empty†.

* It seems to be an argillaceous iron ore, similar probably to the one at Ashburnham, used for the manufacture of Tripoli, and belonging to the Hastings sands.—See Fitton's *Geological Sketch of the vicinity of Hastings, page* 50.

† "Brogniart alludes to something similar to these tubular bodies, enclosing the roots of plants in sandy places, where the iron appears to aggregate the sand round the roots; and he concludes the paragraph by confessing his inability to assign the cause producing it 'et dans ces-çi la cause qui a accumulé l'oxide de fer à l'entour de la racine .... est encore difficile à assigner.—*Tabl. des Terr. qui composent la Surface du Globe, page* 56.'

My friend Mr. Malcolmson, Secretary of the Madras Medical Board, writes to me as follows: On the banks of many of the streams in the Deccan, the black soil is seen penetrated by tubular *incrustations*, resembling *kankar*; they are evidently formed round the roots of plants, the decay of which leaves a cavity which may sometimes be seen to divide and ramify. Some of those in the banks of the Kanar river, Kamptee, near Nagpore, are more than an inch in diameter.—B.

Sergeant Dean's Jumna collection exhibits many incrustations of calcareous and ochreous matter of a similar nature.—Ed.

Immediately below the vegetable soil, in almost all places, we find a stratum of detritus (in general not above a few inches thick), which is different in different localities, according to the nature of the rock on which it rests. Thus, it is ferruginous on those places where iron ores are found: quartzy and silicious above the thick veins of quartz, which intersect these rocks. But in general it is composed of small fragments, sometimes rounded, and sometimes angular, of the decomposed rock (of which we shall speak hereafter), being identical with that we see on the surface of the soil (No. 7).

The simple inspection of this detritus, overlying, and corresponding in position and nature to the subjacent rock, forces upon us the conclusion, that it does not belong to the alluvium (terrains de transport), but that it has its origin in the disintegration of the rock *in situ*, without any, or any material displacement from the rock which has given rise to it.

Another fact that proves this detritus to arise from the decomposition of the underlying rock, previous to its becoming lithomargic earth, and while in the dry friable state which seems to have preceded it, is, that the porcelain earth, wherever this last earth is found in large beds below the vegetable earth, is never overlaid with detritus; because the rock is all at once converted into porcelain earth, without the intermediate passage into the dry friable rock, from which the detritus arises.

This detritus is seen almost in all localities on these hills; the numerous sections that have been made in their declivities, for the new roads, show it clearly every where. On looking at the banks on the sides of those sections, we observe the detritus adapting itself to all the irregularities and zig-zags of the subjacent rock, or stratum. Fig. 2 of Pl. XXXI. shows this conformity better than any description. It is taken from the bank of the road round the lake near the bund.

That this detritus has not been transported from any distance is further proved, by observing it on the surface of the soil in those places where the protruding rocks are either decomposed or decomposing. We often see the still undecomposed nucleus of the rock protruding through the soil, surrounded and enveloped by the numerous concentric layers of the decomposed rock, the bassets of which we see level with the soil, the upper portion of them having been disintegrated into a detritus, which is scattered on the soil in the vicinity of the blocks. As far as I know, no organic remains have hitherto been found either in this detritus, or in the black soil.

In some places the detritus, for causes difficult to guess, assumes

a degree of hardness, and approaches a conglomerate; the small rounded pieces being agglutinated by a clayey paste, resembling a pudding-stone. This is particularly the case in those localities where it overlies the iron ores, so abundant on these hills. When the subjacent rock is the hematitic iron ore, the conglomerate resembles exactly the pisiform, or oolitic iron ore, and in some places it is hard enough to be used for architectural purposes. The conglomerate in this state of aggregation is similar to some varieties of laterite found in the plains of the Carnatic. But this pisiform iron ore is not to be confounded with another rock, which also resembles laterite, and is met on these hills in enormously thick beds, hereafter to be described.

Below the detritus, in almost all places on the hills, we find a thick stratum of an ochraceous red earth, which occasionally assumes both the appearance and the composition of lithomarge, and for this reason, I shall call it hereafter indiscriminately either lithomargic, or red earth. In some of the lower hills, this stratum is above 40 feet thick, as it is near the bund of the lake. It is this red earth, which, filling up the interstices among the original inequalities of the projecting rocks, has given the hills their rounded appearance, by smoothing all the asperities and irregularities of the original rock; or, to speak more correctly, the projecting points themselves have been smoothed down by their own decomposition into lithomargic earth.

In general, this red earth is of a mottled colour, or streaked with different hues of red, yellow, crimson, white, and grey or brown. It feels unctuous to the touch, and crumbles into dust when pressed between the fingers. It does not form a paste with water, but subsides to the bottom of the vessel. The different colours of this earth are separate and distinct, having a decided line of demarcation, so as to show that they are produced by the decomposition of separate and distinct minerals. We occasionally find in it thick veins of pure white felspar decomposed into porcelain earth, traversing it in all directions; precisely as we observe the same veins of felspar, in an undecomposed state, traversing the hard rock, which forms the hills.

This red lithomargic mould is evidently the result of the decomposition of two of the rocks, which almost exclusively form the Neilgherries; viz. the sienitic granite, and the hornblende rock, or primitive greenstone; of both which we shall speak hereafter.

It seems that before the rock is transformed into red earth, it passes into a dry friable substance, which sometimes has consistence enough to be cut and used for architectural purposes; many of the stones used in the construction of the Kúnúr bridge, are of this nature. The second stage of the decomposition is that, in which it

becomes of a soft consistence and earthy texture: the minerals composing the rock still retaining their relative position as before. Thus we see in the lithomargic earth, what was hornblende, changed into a red ochrey substance; the felspar into a white clay; the numerous garnets into a crimson-coloured clay; the quartz alone remaining unaltered and undisintegrated, which, after all, occurs but in a very scanty proportion in the rock (No. 12).

It is curious to observe, that the substance of the crystalline rock is not protected from decomposition by the thick layers of its own decomposed substance; and notwithstanding its being buried many feet beneath the surface of the soil, under a thick stratum of vegetable earth detritus and lithomargic earth, the decomposition appears to be going on without the concurrence of the atmospheric air.

In many places the entire block has undergone the process of decomposition, and in the sections for the roads, we occasionally see many concentric layers of the decomposed rock, like the coats of an onion when cut transversely. It is not rare to observe, that these coats have, in many localities, a kind of crust (*enduit*) of a black substance, probably oxide of iron (No. 13). The decomposition of the rocks takes place from outside inwardly, and appears to proceed, or to have proceeded gradually. It seems that the felspar and the hornblende are the first to be decomposed, the one (losing the alkaline matter? Sir H. Davy) becomes opaque and whitish; the other, by the hyperoxidation of its iron, is converted into an ochreous clayey substance: the garnets do not resist decomposition long; but the only change that the quartz seems to undergo is in its degree of compactness; becoming friable, and easily reduced into sand by the fingers.

If observations and facts were wanting to prove that this thick mass of lithomargic earth is owing to the decomposed granitic rock of these hills, the following is conclusive. The original undecomposed rock is, as I have said, traversed occasionally by thick veins of quartz. These veins resisting decomposition (which affects the remainder of the ingredients of the rock) are seen *in a continuous course, penetrating from the hard crystalline undecomposed nucleus of the rock into the lithomargic earth, and into the concentric layers of the already decomposed rock.* Therefore, it is impossible to avoid the conclusion, that the red earth and the rock were, at one time, *one mass, traversed by the quartz vein,* which is still seen *continuous* and entire, notwithstanding the transformation of one-half of the rock into red earth.

The appearance I have just described, is seen on the N. bank of the road, which descends from Ootacamund to Kaití valley, after the steepest descent of the Kaití pass is finished; and, I dare say,

may be found in many other places, which I have had no opportunity of visiting.

What I have said of the quartz veins is also applicable to the more numerous felspathic veins, which traverse the rock; with this difference, that they are decomposed, and converted into porcelain earth, while those of quartz are entire and unchanged. But the *continuity* of the vein is evident, although one-half of it has changed nature.

An additional, although negative, proof regarding the transformation of the granitic rock into lithomargic earth, is, that on those hills where no rocks containing hornblende are found, this earth is wanting. This is the case on the summits of Dodabetta, Elk Hill, Kaití pass, &c., in which places the protruding rock being either granite, or pegmatite, it exfoliates in laminæ like granite, instead of decomposing into red lithomargic earth.

It would be worth ascertaining, whether the crimson-coloured dots and streaks in the lithomargic earth be owing to the decomposition of the numerous garnets contained in the original rock. I have had opportunities, more than once, to remark, that in those localities where the sienitic granite abounds with garnets, the lithomargic earth, resulting from its decomposition, has the crimson coloured dots similar to those in the undecomposed rock (No. 14). I have made the same observation in the decomposed gneiss in the Northern Circars, where it abounds with this mineral.

A question naturally presents itself after the above remarks, regarding the decomposition of the granite, and hornblende rock of the Neilgherries. The same identical rocks are found in many parts of the Peninsula, particularly along the chain of the eastern ghâts; and yet their decomposition does not give rise to the same results. As I have visited but very few localities in India where these rocks prevail, I cannot positively say whether or not the result of their decomposition in both localities be the same*. But, this is certain, that the causes, which may have contributed to decomposition in one place, do not exist in the other: of that class are cold, damp, frost, elevation, &c., which are not found in the low lands. Besides, is this decomposition the effect of *existing causes*, or the consequence of *time* and *revolutions* gone by?

Here I must remark, that in some localities, such as near the bund of the lake, on the road below the church, above the bazar, &c. the red earth assumes the composition, texture, and appearance of real lithomarge.

* Doctor Heyne says, "a red soil prevails where sienite forms the apparent ground rock."—*Tracts Historical and Statistical on India, page* 349.

As I have proposed to abstain from speculations, and from far-fetched theories, I shall not enter into any hypothesis respecting the causes of this decomposition. It is enough to have noted a geological fact, which requires but simple inspection to be certain of its existence. I shall therefore proceed to describe some minerals, which are found imbedded in the red earth; some of which might prove very useful and advantageous in the arts. Such is the porcelain earth, found in enormous beds, and of the greatest purity, in this locality.

This mineral is evidently derived (as it is almost in all places where it is found in Europe) from the decomposition of the pegmatite or graphic granite, which is chiefly met with in primitive districts. As this rock does not appear to be common on the Neilgherries, I found it difficult, at first, to account for the origin of the numerous and thick beds of porcelain clay. It was after visiting and examining the summits of some of the highest hills, that I found a variety of pegmatite forming many of the most prominent rocks on them. Such are the summits of Dodabetta, Elk Hill, Kaití pass, some of the peaks of the Kúndas, and probably many other places which I did not visit.

It is undoubtedly to some of the erratic blocks and rolled masses of this rock, or to the decomposition of those beds of pegmatite, into which the true granite of the high hills seems to pass, that the porcelain earth is owing. Of these blocks, still in an undecomposed state, we see many in the valley of Kaití derived, in all probability, from the summit of Dodabetta, or from that of the rock of Kaití, where the pegmatite is seen *in situ*.

By comparing a piece of this porcelain earth, just taken out of the bed, with a piece of the hard pegmatite rock, one cannot but be convinced of their being the same rock; the one in a hard, the others, in a decomposed state. (No. 15.) The pieces of the crystalline smoky quartz (which is the only other mineral entering in the composition of the pegmatite, besides felspar) are still visible in the same situation, as when the rock had not undergone decomposition, having become more brittle, and easy of disintegration.

The porcelain earth is not to be confounded with that which results from the decomposition of the pure felspar veins, so frequently seen in the sienitic granite. By simply looking at both specimens, the difference is discovered (No. 16). The latter has no sandy particles in its composition, such as are found in the other, which by such addition is better adapted for the manufacture of pottery, in which silicious sand is a necessary ingredient.

I speak with some hesitation regarding a mineral I found only in one place on the Neilgherries, and I am doubtful whether it exists in

any quantity in those hills. It is a brown ferruginous clay, very closely resembling amber, particularly that kind which is exported from the Island of Cyprus (No. 17). I found it between two large blocks of decomposing sienitic granite, or rather hornblende rock, with garnets, close to the bund of the lake.

The next rocks to be described are two metallic ores, in all probability, originally imbedded, as veins, in the rock: which last being now decomposed, they are left imbedded in the lithomargic earth: indeed, one of these ores is still seen as a vein, in the undecomposed rock.

The first is the magnetic iron ore, so common in many parts of India, and which, besides the metal, contains variable proportions of quartz (No. 18). The places where I have met with this iron ore are marked in the map: in some of them the ore is imbedded in the lithomargic earth, while in others it is like a vein in the rock. I saw it in this last position in the road descending to Kaití valley, where the metal is very little in quantity, compared with the granular quartz, which in some parts of the vein predominates to the almost entire exclusion of the metal (No. 19).

The two places on the Neilgherries, where I have seen this ore very rich in metal, are, one near the village of Vartsigiri (Vrotagherry), and the other close to, and traversing, the Lake of Ootacamund in two places. The specimen from Vartsigiri (No. 20) is very compact and rich in metal. I took it from a large block, probably the outgoings of a thick bed at the southern extremity of the valley, at the other end of which the village stands.

Generally speaking, the quartz is lamellar, very rarely granular, and it seems to alternate with the metal in parallel laminæ. The appearance, composition, and proportion of the ingredients of this magnetic iron ore are very different in different places; nay, in the same vein. For instance, the vein seen just below the building called Gradation Hall, between the road, and the margin of the lake, in its N. E. extremity, has a compact, metallic structure, highly magnetic, with hardly any quartz (No. 21): a few yards to the southwest, the vein contains a good deal of quartz; the metal is more oxidated, although maintaining still its magnetic powers (No. 22). Following the vein in the same direction, we see it appear in the opposite side of the lake, in the banks of the road, which goes round and close to the lake. There the ore has lost a good deal of its quartz; the iron is more oxidated, and the rock assumes a kind of columnar structure (No. 23). This is the appearance of the vein in the section for the road. But the out-croppings of the vein at the

top of the same hillock are compact, scabrous, and of a slight cellular texture (No. 24). Going on always S. W., we see the same vein continued over the next hill, close to the road going to the Kundas; and so much divested of iron, that it resembles a friable stratified sandstone, the quartz being granular (No. 25).

It is in this kind of magnetic iron ore, particularly in the blocks below Gradation Hall, that I remarked on the quartz laminæ, small brilliant, gold-coloured specks, precisely similar to those seen in the auriferous quartz veins in the rocks of the Malabar coasts, specimens of which have been deposited by my friend Colonel CULLEN in your museum. Does this appearance indicate the existence of particles of gold in this ore? We know that in America, gold is occasionally found in the siderocriste, which is a species of quartz iron ore, like the one just described*.

It is the belief of some people, that owing to the similarity of the rocks, of the detritus, and of the quartz veins, of the Malabar coast, and of these hills, gold may be found in this last, as well as in the former. The specimen of the earth I send is taken (No. 26) from an excavation made, some years ago, by an officer, who had been employed on the Malabar coast, for the purpose of ascertaining the existence of gold in the detritus of that coast. It is said that he found gold in the earth dug up on the side of one of the hills of the Dodabetta group, facing the cantonment†.

Before concluding my observations regarding this magnetic iron ore, I must repeat what I said in the beginning; that it is found in thick beds, evidently imbedded either in the original rock, or, which comes to the same thing, in the lithomargic earth, the result of its decomposition.

Iron ores are so common on these hills, independently of the oxides of that metal contained in the minerals forming the rock, that many springs of water are of the chalybeate class‡.

* The specimen of Colonel CULLEN is marked "auriferous quartz, stratified: Nelli Allum, Malabar." The same gentleman sent to your museum another specimen, which he calls "auriferous micaschist," which contains the same kind of shining, gold-coloured specks.

† The sand which results from the desintegration of this species of iron ore is very nearly similar to what is called titaniferous sand.—Does any menaccanite exist in this sand? The rock in which this ore is contained, appears to be similar to that which is seen in Cornwall, from which the sand containing that new mineral is derived. Professor SEDGWICK informs Mr. DE LA BECHE, that the menaccanite of Cornwall is derived from the *decomposition* of a *hornblende rock*, composed of hornblende and felspar.—*Geological Manual.*

‡ BAIKIE's Observations on the Neilgherries, page 14.

The next species of iron ore on the Neilgherries is the hæmatitic, forming immense beds, and sometimes whole hillocks, among the hornblende rocks, and sienitic granite. In all the places where it is found, large blocks of this ore are seen projecting through the soil, having a scabrous, cellular, and sometimes cavernous appearance at the surface.

As this rock resembles very much the laterite of this part of India, I shall be more particular in describing its geological position and association, in order that it might be seen whether it ought to be classed with the laterite of the low lands, or among the iron ores found in many other parts, associated and in veins, in primitive districts.

Before entering into the description of this rock, I must remark, once for all, that the position and association of the rocks on the Neilgherries is not so easily ascertained, and clearly seen, as in other localities of India, on account of the enormously thick stratum of red earth and vegetable soil, which cover uniformly the whole plateau. So that we are often reduced to the necessity of judging of the nature of the rock composing the hills, by the few projecting masses at the top, or on its declivities.

It is for this reason, that I am unable to say positively whether the rock I am going to describe be overlying, or one of those metalic veins which traverse the original rock; although I have more than one reason to surmise, that the last is the position of this ferruginous ore on the Neilgherries.

All I have been able to ascertain regarding this ore, may be detailed by describing one or two of the localities, where this formation is seen developed in a more marked manner than any where else on the Neilgherries.

The most extensive formation of this hæmalitic iron ore is seen on both sides of what I shall call Scotland Valley*. It is the valley through which the superfluous waters from the lake discharge themselves into the Moyar river. This valley runs nearly E. and W. above two hundred yards below the bund of the lake; close to the left bank of the stream, we see a large block of compact iron ore jutting through the soil (No. 27). Proceeding westward along the right bank of the torrent, for about a quarter of a mile, we come to a place where the stream is joined by another flowing from the S. W. On both sides of this river (until we come to this junction), the projecting rocks,

* Sir Frederick Adam, our present Governor, while on the hills, used to call it by that name, on account of a resemblance he saw in it to some place in Scotland.

which in some places make up knolls and hillocks, are of the usual sienitic granite, with a good deal of hornblende and a few garnets.

On fording the river, at the place of junction, we see on the opposite bank all the projecting rocks to have totally changed their character; they are now cellular, hæmatitic iron ore, rich in metal (No. 28). That rock is seen protruding through the soil of this and of the next hill (W). Some of the enclosures for cattle on the declivities of this hill are constructed with large masses of the cellular iron ore, which however in some of them has a very compact structure (No. 29).

The highest of the two hills appears to be entirely formed of this rock, of which huge masses are seen in the intervening ravine. On the summit of the highest hill, the rock assumes a pudding-stone-like structure, being a hard conglomerate of numerous rounded pieces of ferruginous clay iron ore, strongly agglutinated together by a clayey cement (No. 30). A prodigious number of these rounded pebbles are scattered about, covering nearly the whole of the summit of the hill (No. 31). Many of the hard blocks of this conglomerate resemble very much (if they are not identical with) the laterite of the low lands of India.

Descending from the summit, along the western declivity of the hill (facing Pinnapal Hill), and only a few yards from the top, the rock insensibly changes its appearance and structure. It becomes by degrees more compact, and loses its cellular structure; in short, it assumes the compact appearance of common hæmatitic iron ore (No. 32), very rich in iron; and in this state it continues to the foot of the hill on that side, where some of the projecting masses of this iron ore are flanked by others of sienitic granite, or rather hornblende rock.

These two hills, on the N. E. side, and at their foot, close to the stream, are skirted by immense masses of sienitic granite, through which the waters of the river are heard roaring; except at one place, at the foot of the high hill, where the river is forded to go towards the new road from Nandiwatam to Ootacamund. In that place the iron ore bed crosses the stream; forms numerous projecting masses on the slope of the opposite hill, having a N. E. direction; crosses the road of Nandiwatam, and terminates in the summit of the hillock to the N. E. of the road; beyond the latter place, this rock cannot be traced.

Now this filon of iron ore, after crossing the stream of Scotland Valley, is *evidently* and *clearly* seen *flanked* on *both sides* by sienitic granite, jutting in large blocks through the soil, in the very same way

as the masses of the iron ore shoot up; and therefore, it is fair to conclude, that the last do not overlie the former.

I must here call the attention of the reader to the almost imperceptible transition of the cavernous tubular kind of ferruginous conglomerate, into the uniformly compact hæmatitic iron ore of this hill: an appearance that I had an opportunity of observing also in the Northern Circars at Pandagaram, near Samalkátah, where the compact, slaty hæmatitic iron ore is seen passing into a conglomerate very much like laterite (Nos. 33 and 34).

Another view of the hæmatitic ore is obtained below the bluff rocks of the summit of Dodabetta, beyond the villages of Mantú, close to the road, which descends from the hollow between Kaití rock and Dodabetta. Coming towards Ootacamund, we see huge masses of ore protruding through the soil (No. 35). It is scabrous and cellular, but not perforated by tubular sinuosities like the laterite. It is similar to some of the masses of the same ore on the declivities of the hills of Scotland Valley. This vein has but a few yards' thickness, having a N. and S. direction. On both sides of, and nearly in contact with the blocks of ore are seen masses of sienitic porphyry, or rather hornblende porphyry, containing some garnets (No. 36), which, as we proceed towards the villages of Mantú, lose the garnets, and become hornblende rock (No. 37).

The two hillocks S. E., and close to the lake, and on which Cluny and South Down houses are built, are chiefly composed of the same iron ore. The sections in these declivities, on account of the road which goes round the lake, show the ore decomposed into a red clayey earth, imbedded in the lithomargic earth, resulting, as we have seen, from the decomposition of the original sienitic rock.

The same ore is seen near the summit of Dodabetta, on the hill before descending into the Elephant Valley, and in other localities, which it would be superfluous to describe, after having detailed the principal features of those places where it most abounds. I must, however, here recall to the memory of the reader what I have said, speaking of the detritus below the vegetable earth. It is in the localities, which abound with this iron ore, that the detritus is composed of ferruginous rounded pebbles, occasionally cemented together into a hard conglomerate, like oolitic iron ore, by a clayey paste.

The hæmatitic iron ore seems to contain some felspar, which in this rock is decomposed into a yellowish clay, lining some of the cavities in the rock: but I never found any quartz in it.

Before concluding these details regarding this iron ore, I will point out some particularities, in which (notwithstanding its similarity in

appearance) it seems to differ from the laterite of the other parts of India, that I have had an opportunity of examining. The rock of the Neilgherries is by no means so cavernous, and has not so many tubular sinuosities as the laterite of the Carnatic, Northern Circars, &c.; it seems also to be richer in metal, and, what appears to constitute a marked difference, it is entirely divested of any quartz, or sandy particles, which abound so much in the laterite of other places. Besides, we are told by Doctor Heyne, that in the laterite of the Red Hills, Nellore, &c. a marl or carbonate of lime is occasionally one of the ingredients; no traces of this carbonate are found in the stone of the Neilgherries*.

That this rock of the Neilgherries is to be classed with hæmatitic iron ore, rather than with the true Indian laterite (an overlying rock), is very probable, considering that rocks similar in appearance to it are found in Europe, while the last is peculiar to India†.

It is said of the Indian laterite, that it is associated occasionally with trap. On the Neilgherries, basaltic dykes are not rare, yet I never saw what Voysey remarked in other parts of India, viz. the passage of basalt into wacke, and into iron clay, (by this last name, meaning laterite;) another additional difference between the two rocks.

Hitherto no organic remains have been found in this rock on the Neilgherries, which appears also to have been the case with the laterite of the other parts of the peninsula.

I am not positive regarding the existence of manganese on these hills: my friend Colonel Cullen says, that it is found mixed in the iron ore near the lake; and I found a straggling piece of this ore in the valley of Kaití (No. 38), which I have not analysed, but which has all the external characters of one.

The lowest visible rock of the Neilgherries is of the primitive unstratified class, including true granite, pegmatite, sienitic granite, and hornblende rock: sienitic gneiss, and hornblende slate are occasionally seen, but they belong more to the outskirts of the hills than to the group itself. Besides these rocks, we find granitelle, and a rock composed of four minerals, felspar, hornblende, garnets, and quartz.

True granite, composed of felspar, quartz and mica, is not of rare occurrence; it frequently occupies the summits of the highest hills: thus it is seen in some of the Kúndá range, and of the Dodabetta group;

* Tracts.

† If my memory serves me right, I think I saw in your museum a specimen marked "black, brown, solid and perforated iron ore, from Poetz in Upper Lusatia," which appears to me similar to the Neilgherries hæmatitic, cavernous iron ore.

‡ No. 38 is decidedly an ore of manganese.—Ed.

I never saw it, except in the form of erratic blocks, in the low valleys (No. 39). In those places it has the usual appearance of immense masses split both by vertical and by horizontal fissures, into columnar or prismatic figures; they, however, no where assume the tor-like appearance so common in the granitic hills in other parts of India. The granite occasionally is of a dull, yellowish brown colour, owing to the felspar, which assumes that tint, resembling in that state the *feuille morte* of the French. Doctor Hardy has remarked the same change of colour in the granite of Mewar.

The other species of granite, found always associated with the former, is the pegmatite (No. 40), a rock composed of only two minerals, felspar and quartz. The places where I have found this rock *in situ* are marked in the map: it is a variety of the graphic granite; in aspect very different from the same rock found in other parts of Southern India, in which the quartz is regularly crystallized, and the felspar in long slender crystals, of a pale flesh colour.

In the variety of this rock on the Neilgherries, the felspar is milk-white, lamellar; but not in regular prismatic crystals: the quartz is occasionally of a smoky colour or bluish; and in angular pieces, this colour is sometimes so deep as to appear nearly black. In some of the masses are occasionally seen a few garnets, or a little hornblende; but in general, the rock is exclusively composed of the two minerals, felspar and quartz*.

Of this rock some erratic blocks are seen in the valleys, at the foot of those hills, the summits of which contain it *in situ*: this is the case in the Kaití valley, whither many of these boulders have been probably hurled down either from the summit of Dodabetta, or from the Kaití peak, where pegmatite is found.

It is undoubtedly from the decomposition of these masses, that the porcelain earth described in the beginning of this sketch, arises. By comparing the specimens of the one with those of the other, the identity of the two is established.

The sienitic granite varies in the proportion of its component minerals, and therefore in appearance; sometimes approaching diabase (primitive greenstone), and at others, granite (No. 41½). It almost always contains garnets as one of the minerals composing it; and when this mineral is abundant in the rock, the quartz diminishes in proportion. In the Dodabetta group, I have remarked in some

* This species of granite seems to be very common in many parts of India,—Dr. Hardy appears to describe it in many localities, in his sketch of the Geology of Central India. Many of the blocks jutting up in the plain between Palaveram and Madras, such as that near the Race Course, are all pegmatite.

places the garnets, instead of being either amorphous, or in angular crystallized pieces, assume the granular form, resembling colophonite; in which case, the rock containing it assumes a stratified appearance (No. 41).

The colophonite is composed of granular garnets, greenish hornblende, a little felspar, and less quartz. I have seen in your museum a specimen sent by Strūve from Norway, very much like the specimen I now send. The geological position of this rock, which I have found in one or two localities only, is the following. It is to be seen clearly in the ravine just above the high road going to Kúnúr, and close to the public bungalow of Kaití. Two huge masses of a black-looking unstratified rock are seen overlying three strata of a different rock. The upper and unstratified mass is a hornblende porphyry, which passes into sienitic granite. It is very nearly similar to the rock of the same composition I have mentioned as flanking the hæmatitic iron ore, behind Mantu village (No. 42). I have found precisely the same rock overlying the sienitic porphyry of the Garabunda pass, in the Northern Circars. Its hornblende is shining and lamellar, and is the most abundant of the component minerals; the garnets appear to be surrounded by a white powdery opaque felspar, they themselves half decomposed. Below this half-rounded mass is a stratum of a felspar rock, with a very little quartz and hornblende decomposing (No. 43). The thickness of this stratum, which is uniform, does not exceed a few inches; another, but thicker stratum of a granitic rock, lies under, and conformable to the above, being composed of reddish felspar, some garnets, little quartz, and mica; the passage from one rock to the other is sudden, decided, and well marked. Under this, and conformable to it, is a stratum of a rock almost entirely composed of hornblende and granular garnets: this is the lowest of the rocks seen; it becomes harder as it descends, when it assumes the appearance of colophonitic hornblende rock.

This lower rock appears stratified, and besides the seams of stratification, it has some fissures, perpendicular to them; so dividing the stone into prismatic portions. On account of the thick stratum of soil at the foot of the rock, I could not ascertain whether the last-mentioned was the lowermost rock. I must here remark, that the appearance of the two rocks immediately under the hornblende porphyry was that of a decomposing stone, as if from the action of fire.

The rock which prevails in the Kaití range, as well as in other places, is the one which abounds both with hornblende and amorphous garnets. These last sometimes are of a large size, and not

dispersed through the rock, but, as it were, in nests (No. 44). This rock is very like the specimen in your museum from Norway, marked "large garnets in hornblende." Indeed, I think that there is great analogy between the *sienite zirconienne* of Norway and this rock of the Neilgherries (No. 45). I remarked in one place of the Dodabetta group some veins containing quartz and garnets; the last in the granular or resinitic form (No. 46).

Before dismissing the subject of the hornblende rock, I must remark, that although this primitive greenstone is occasionally seen on the summit of some hills, in general it occupies the declivities or the lowest parts of them; and it often assumes a brilliant, laminar crystallization, being then exclusively formed of hornblende (No. 47).

I have seen it passing into hornblende slate at the foot of the Neilgherries, at the bottom of the Kúnúr pass. Here its strata dip to the east, and I am informed, that the same stratified rock is found at the foot of the same group of hills, to the west, the strata in that place dipping west. It is in those places that this rock occasionally passes into sienitic gneiss.

These are all the rocks I have met on the Neilgherries, of which their extensive plateau is formed, and the relative position of which can often only be surmised, on account of the thick covering of soil, and of red earth, which conceals the rock generally.

I must in the last place notice the numerous basaltic dykes which burst up through all these rocks indiscriminately, without however overlying them, except in one situation; and even there the basalt only forms a small ridge, flanked by the fundamental rock.

I shall describe briefly those places where I have had opportunity of examining this rock; and first, that in the Kúnúr pass. Not more than a mile from the bridge down the pass, and just below the village of Kúnúr, in the road, many of the blocks which have been blasted, are traversed by a dyke of basalt. In the little ravine close to the road, the dyke is seen *in situ* through the masses of granite in the jungle. This dyke divides in two or three branches, inclosing betwixt them the granite; then it is seen continuing in a north direction, till close to the huts of the village. The projecting masses through the soil indicate the direction of the thick dyke, which in a place near the road is divided in well marked prisms above the granite (No. 48).

This basalt is very compact; has a dull, even fracture; but in one portion of the dyke, I had the opportunity of observing, that the part which was in contact with the granite had the appearance of a crystalline hornblende, which passed into compact hard basalt towards the centre of the dyke. I also remarked, that where the dyke

was in contact with the granite, the basalt was projecting in a small ridge, which was divided into small prisms, as if the consequence of sudden refrigeration, and subsequent contraction (No. 49). The masses under the village, exfoliate into concentric laminæ, in which are some needle-shaped shining crystals, probably of augite (No. 50).

Another enormous dyke of this rock is seen in the chain of hills which connects Dodabetta with Kaití pass. The summit of the hill, which is between those two mountains, is formed of basalt in huge masses, some of which affect the prismatic figure. In general the large blocks are not so compact as the thin ramifications of the dyke traversing the rock, but the hornblende in the former is nearly granular and shining, somewhat approaching primary greenstone.

On the eastern and western *slopes* of this little ridge, the rock, of which the hill seems formed, is seen in huge projecting masses, so that the basalt does not appear to overlie the rock, but to have burst through it, vertically, in the centre of the ridge.

Going along the ridge from N. to S. after passing a little hollow, we ascend the hill, the summit of which is basaltic. The first intimation we have of the existence of this rock, is seeing many of the blocks of pegmatite traversed in all directions by a reticulated infiltration of basaltic matter (No. 51). On looking at the surface of the blocks level with the soil, we see it divided in irregular portions by the ramifications of the dyke.

Examining some of these masses, we see evidently that, in many of them, the thickness of the dyke diminishes as it proceeds upwardly, and therefore showing the injection of the basalt to have taken place from below. The following appearance exhibited by one of the blocks, shows clearly this direction of the basalt. It is a large mass of pegmatite exfoliating in thick laminæ. Portions of one of these had been removed, either by disintegration or otherwise; the remainder (perhaps a foot thick,) was still overlying the nucleus of the rock, which was nearly level with the soil. A basaltic dyke, an inch thick, was observed in the nucleus of the rock, which had been denuded of a portion of the laminæ; but this dyke did not penetrate into the upper remaining portion of the laminæ, which was incumbent on it. This dyke continued evidently under the remaining portion of this laminæ in the nucleus of the rock.

Going from Ootacamund towards Nundiwatum, along the new road, after about three miles, we meet with two basaltic dykes close to the road.

The first is seen near a small stream, like a ledge projecting at an

angle with the horizon, and the basset of which is hardly a foot above the soil. Its dip is west; its direction nearly N. and S.; and it is seen continued along the declivity of the hill for some hundred yards. It is traversed by fissures in different directions, giving the pieces a prismatic appearance. Proceeding N. we see in the next hill another and thicker dyke, with precisely the same direction as the former.

The basalt in this place traverses sienitic granite, and it is seen clearly on the side of the road. The pieces of all shapes, as prisms, cubes, rhombs, are strewed below the newly cut road. Above the road, the projecting masses of sienitic granite are traversed by innumerable ramifications of the dyke, enclosing between them pieces and masses of the fundamental rock (No. 52).

The same observation made when speaking of the Kaití dyke, is also applicable to this: the small basaltic veins have a compact, and dull texture, while the body of the dyke itself has a granular-like structure, and somewhat shining (No. 53).

In some of the Kúnda mountains, as that of the Avaláche, I also noticed some of these basaltic dykes; and judging from the numerous rounded blocks and pieces of basalt seen in the bed, and in the banks of the river, which descends from the hills N. of the Avaláche, basalt must be very common in that group.

Basaltic dykes are not rare in those places, which I have had an opportunity of visiting in the plains of India. I have seen them through granite and gneiss in Mysore; through porphyry, near the erratic hill of Adamanacotta; through hornblende slate, near Mottipollium; through porphyry, near Garabunda (Northern Circars), and in many other places. Are these dykes the fissures through which the enormous mass of trap, overlying most of the rocks of the peninsula, burst up? and which, subsequent events and revolutions having removed, the vents only through which it was forced up remain to be seen?

It is a well-ascertained fact that the structure, if not the nature, of rocks in contact with the basaltic dykes, is often greatly changed or modified. I saw nothing of this alteration in the rocks close to the dykes I have been describing. The specimen I send, shews no other change, except a slight diminution of cohesion among the composing minerals, and that not in a very marked manner, nor in every locality.

---

The above described are the rocks I had an opportunity of examining on the Neilgherries, having met none of the secondary, and much less of the tertiary class. It would appear from this, that the elevation of this plateau, and probably of the whole chain of the western

ghats of which the Neilgherries are the southern termination, happened at a period long anterior to the existence of life on our planet.

It is for this reason that I think Humboldt's opinion not supported by facts, when he says, " the chain of the Ural, the Baloor tâg, the ghats of the Malabar Coast, and the Vringckan are probably more modern than the " Chains of the Himalaya, and the Teenckan*. We know, that in the Himalaya, at several thousand feet elevation, and on the declivities of the highest ridges themselves, organic remains have been found in limestone, which seems of the age of the carboniferous group.

The nummulitic limestone of Chira Punjí, and the conglomerate rock, which forms the Deria Dún at the foot of the Himálaya, appear to assimilate those mountains to the Alps†. Therefore the Himalaya must have been heaved up at a period posterior to that when the Western ghats were elevated: these last containing not a trace of organic remains in the rocks which form them, while the former abound in them.

Elie de Beaumont admits the greater antiquity of the Malabar ghats over the Himalaya chain; but he conjectures, by the direction of the ghats being parallel to the Pyrenese-Appenin system, that they may probably belong to his sixth revolution of the surface of the globe. The passage, in which he expresses this perplexity, is worth transcribing, to show of what importance it is to establish the association, and the geological position of the laterite.

" Vouloir suivre ce système jusque dans l' Inde paraitrait peut-être abuser de la faculté des rapprochemens: cependant je crois devoir faire remarquer que la chaine des gâtes sur la côte du Malabar semble se cohordonner à la direction, dont je m' occupe. La grande faille, à laquelle parait dû l'escarpement occidental des gâtes, en élevant le plateau du pays des Maharattes, du Deccan, du Carnatic a élevé du même tems, le grand depôt argille-ferrugineux de laterite, qui forme les points plus élévés de ce plateau, ainsi que le montre la coupe des gâtes donnée par M. Christie. Il est à regretter que ce depôt de laterite, qui couvre dans l' Inde de si vastes étendues, n'aie, jusqu'a present, offert aucun fossile, et ne puisse être rapporté avec certitude à aucun étage geologique déterminé: mais on peut toujours remarquer que

* Edinburgh Philosophical Journal, October to January, 1832, Humboldt on the Mountain Chains—Volcanos of Central Asia.

† A writer in the Bulletin des Sciences Naturelles, concludes that the Dehra Dun is analogous in formation to the Molasse of the Alps; and Doctor Falconer is of the same opinion.—De la Beche, *Geological Manual.*

tant qu'on n' aura pas indiqué d' autre chaine* qui produisse sur la laterite l'effet mentionné cidessus, tout conduit à voir dans les gâtes la chaine la plus récente de la presqu'île occidentale de l' Inde, dont elle est en meme tems le trait geometrique le plus prononcé!"

Then he says in a note, that the Himálaya are more recent than the ghats, and the Andes more recent than the Allaghanys of America.

We see, by what Beaumont says, that he suspects the laterite to be the equivalent of those rocks deposited during the period that intervened between the deposition of the chalk, and the tertiary beds. But fossil remains being the only sure guide in determining the ages of these formations, and none hitherto having been found in the laterite, the question must still remain *sub judice*. Besides, we must remark here *en passant*, that the rocks of that epoch in Europe are all stratified, which is not the case with the laterite.

Before concluding this sketch of the geology of the Neilgherries, we must not pass unnoticed the fact of the absence of all sorts of calcareous formation. Even the widely spread kankar is not met with on the Neilgherries, although we find this travertinic deposit at the very foot of those hills, near Mútúpolium (No. 54).

The total absence of stratified rocks, and of calcareous formations, in this group, seems an additional proof of the remote period of its elevation. The only stratified rock, which appears to have been deposited near the place, through which this plateau was heaved up, is the hornblende slate, which is seen both on the east and on the west sides of the hills, being highly inclined, and having an opposite dip: the group serving as the centre of this anticlinal line.

On looking at the map, we see how the numerous valleys and ravines have a different, and often an opposite, direction. Except three or four of them, which diverge in opposite directions from a central point (Dodabetta), the others are so irregular, that it is impossible to refer them to one and the same cause. They certainly do not belong to the class of valleys of denudation, much less to that of corrosion by the streams: the volume of their waters being so very insignificant and divested of pebbly or sandy detritus, which so much hastens the corrosion of the rock, through which the rivers pass. They probably are the original consequence of the elevating force, which either irre-

* "With regard to this part of this passage, to show that there are other chains, having different direction from the Malabar ghats, on the summits of which we see the laterite as an overlying rock, we may quote some of the branches of the Vindiya range, where the laterite overlays either basalt or sandstone; and also many sandstone hills on the Northern Circars: and yet the Vindiya Chain has a different direction from the Malabar ghats.

gularly applied to the different points of the area, or the mass itself, yielding irregularly in the different situations, gave rise to the inequality of the whole surface of these hills.

To conclude, therefore, it seems that the granitic rocks, which occupy the highest hills of this group, forced their way, and were heaved up through the hornblende slate, which was in consequence distorted and lifted up, as it is seen in the outskirts of the plateau, and in some of the low situations among the hills themselves, (the valley S. and close to Kotagherry;) we must also conclude, that the decomposition of the rock forming the red earth, and the detritus, must have happened at a period anterior to the existence of organic bodies; no remains of which have hitherto been found in them.

---

*Specimens from the Northern Circars.*

The specimens (from No. II. to No. IX.) are from the hillock near Puddapungalí; a place not far from Yornagorium, and about five miles from, and south of, Rajahmundry.

After traversing the alluvial plains of Ellore, the road passes near a knoll, the rocks of which are very interesting in a geological point of view.

Before reaching the foot of the little knoll in the plain, and in the nullahs, are seen numerous pieces and blocks of a hard whitish limestone, spotted in many places with numerous small black specks. This limestone is compact, the fracture glimmering on account of the many grains of calcspar which enter into its composition.

In the deep nullahs, in the plain, and at the foot of the hillock along the road, we see a conglomerate sandstone, which appears to be the lowest visible rock in this place. Ascending the gentle slope of the knoll, we come upon many masses of wacke, which is decomposing in thick concentric layers. Proceeding a little higher we meet with a thick bed of limestone, similar to the pieces scattered about on the plain.

This limestone abounds with fossil shells, which are clearly and better defined in the upper than in the lower portion of it, where the rock assumes a tufaceous consistence, friable, and almost approaching the appearance of tertiary limestone. The shells are very numerous in this upper stratum; almost the whole rock results from their assemblage; they appear to be chiefly bivalves, with a few univalves. Many of the shells have disappeared, their impressions only remaining; but the oysters which abound in this stratum are in excellent preservation, and easily characterized.

This stratum of limestone, the basset of which is only visible in

the slope of the hillock, has a W. and E. direction. It is overlaid by a thick mass of basalt, which caps the whole hillock. In some places, where this basalt lies immediately over the wacke, this last is converted into jasper. Huge masses of basalt are strewed on the top of the knoll, which forms a kind of table-land extending eastward: some of these blocks in their upper surface assume an amygdaloid structure, the cavities being filled with calcspar.

I could not in that locality see whether the lower compact limestone was or was not stratified. The more superficial and loose blocks, scattered about on the soil, had no appearance of stratification.

Judging from the appearance of the whole of those hillocks which stretch from N. W. to S. E. in the neighbourhood, they seem to have the same geological features as the one just described. Indeed, my friend Colonel Cullen, with whom I was examining this knoll, told me, that in some of the neighbouring hills, the position of the limestone and of the basalt is seen more clearly, on account of the abruptness of some of their sides, and the deep ravines which intersect them in every direction, so shewing the order of superposition in the four rocks; which is the following: conglomerate red sandstone supporting the wacke, overlaid by limestone, which is covered by basalt*.

The specimens marked X. and XI. are from the diamond mines at Mallavelly, near Ellore; they appear similar to the alluvial detritus in other localities in India, where this gem is found. The kankar accompanies the deposit in the same way as every where else.

No. XX. is the gneiss of which the hillock near the village of Carvera, close to Púndy, is found. In it the Cleavelandite replaces the laminar felspar, and is seen not only disseminated through the substance of the rock, but forming small strata by itself in long acicular crystals†. It is associated, in this rock, with a prodigious number of amorphous garnets, of which some of the strata appear entirely formed.

The porphyry, No. XII., is from the hills which form the northern boundary of the Garabunda pass, going from Kimidy, Garabunda, Cassibogah, to Púndy.

The hills to the south, and close to the pass itself, are sienitic granite, (No. XXXIII.;) while those beyond the porphyric hills to the N., towards the high hill of Mehendry, seem to be formed of that

* The trap near Sagur, described by Captain Franklin, appears to have the same association of rocks as the one of which I send specimens.—*Asiatic Researches, vol.* xviii. *Geology of a portion of Bundelkhand, &c., page* 30.

† Is this the Pindyray of the Telingas, mentioned by Doctor Heyne in his Tracts, page 283?

variety of gneiss abounding with albite, the continuation of which is seen N. and near Pundy.

These porphyric hills, therefore, may be considered as the out-goings of an enormous dyke of porphyry, which burst through the hills, having the same direction with them, that is N. E. to S. W.; their appearance is that of huge masses of a black looking unstratified rock; in many places completely divested of any sort of vegetation, particularly in those hillocks, which like the one called Chittakúnda, rise in abrupt, vertical cliffs, which seen within a moderate distance might be taken for basaltic rock.

The porphyry exfoliates in thick concentric laminæ, the more depending portions of which falling off, leave the upper in immense tabular masses, or cubic blocks, perched on the upper part, and sometimes on the declivity of the hill: this porphyry has a good deal of hornblende in its composition, sometimes so much, as to become hornblende prophyry.

In more than one of these masses of porphyry, I remarked thick veins or nests of a granitic rock, or rather gneiss, with pieces of sienitic granite imbedded in it. The crystals of felspar in this porphyry are well defined, many of them two or three inches long, and of a foliated structure. This porphyry seems, as I have said, to extend as far as near the sea-shore at Pundy. Some huge masses of it are seen jutting through the soil about a mile north of the village of Carvera, flanked by the gneiss containing ablite and garnets.

I have put up many specimens of laterite from different localities, by which may be clearly perceived the distinction between the *original* rock and the *conglomerate* bearing the same name; but which evidently arises from the conglutination of the detritus of the former. This appears to be the case with the laterite in some places of the plains of the Carnatic.

The specimens (No. XXIII. to XXVI.) are from the hillocks, on which the fort of Puddayaram (near Samalcottah) is built. The position of the visible rocks in this place is the following: the ferruginous sandstone is the lowermost, and has a great degree of compactness, so as to fit it for architectural purposes, in which it seems to be largely employed. It is evidently stratified, the strata being nearly horizontal; the quartz particles are agglutinated by a ferruginous cement.

The sandstone, nearly in the whole extent of the hillock, supports a lithomarge of a whitish or flesh colour, sometimes having a bluish tint. The stratum of this earth is not very thick, and in many places, it is overlaid by a purple-red, compact, slaty hæmatitic iron ore,

*which passes insensibly* in the upper part into a cellular rock, full of tubular sinuosities, very much similar to the laterite. In some places this ore lies immediately over the sandstone, without the intermediate lithomarge.

Before I finish speaking of the laterite in these low lands, I must mention an interesting fact I observed in the thick beds of laterite, which caps the hill on the foot of which Bimlipatam stands. In this place it overlies the garnetic gneiss so common all over this part of the country; and I was surprised to see a *large piece of the subjacent gneiss imbedded in the thick bed of laterite*, more than a foot above the point of contact of both rocks. This fact seems to countenance the inference of the detrital origin of the laterite of these plains and eminences. I am not aware that any pieces of extraneous rocks have been noticed as imbedded in the original laterite.

---

## II.—*Notes of a Tour through Palestine.*

[We have been favored with the following extract from the private letter of a junior revenue officer in the Madras Civil Service, by the friend to whom it was addressed without any view to publication. This will be the excuse, if any such be required, for the cursive style in which it is written, to ourselves a strong recommendation in its favor.—Ed.]

Egypt is the most delightful country in the world to travel through; the boats (if previously ordered from Cairo) are the most comfortable conveyances imaginable. In all the great towns you get excellent leavened bread, and in every village, delicious milk, butter, eggs, fowls, and vegetables. I never lived so well in my life; and the weather was so cool and bracing, that I had a voracious appetite, and enjoyed all the good things. Barring the voyage up the Red Sea, (which except in the steamer is dreadful,) and the journey across the desert from Cosseir, (which is decidedly disagreeable,) I know no place so well calculated to re-establish the health of an Indian as the voyage down the Nile, between the months of October and April; but perhaps January and December are too cold for enjoyment.

My friend and myself left Cairo in the beginning of April, and travelled by land through El Arish, reaching Jerusalem in 14 days. This desert, though tedious, is not near so much so as that from Cosseir. Part of the way at first lies along the edge of the Delta through the cultivations, with plenty of water, and from El Arish, the road is delightful, through the finest pastoral country imaginable. From that place I have been pleased, more than I can tell you, with every thing I have seen in Syria, and have been agreeably disappointed in almost all my pre-